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ABSTRACT

A study investigated the nature of clear and dark sounds (resonance) in English, focusing on the features associated with the lateral consonant /l/. Subjects were three male undergraduate students and one male university faculty member, all native speakers of different English varieties. Each subject read aloud 27 short phrases or sentences. Using computerized sound spectrography, resonance patterns (clear or dark), tempo, and duration were analyzed for initial and final /l/. Results support the hypothesis that darker tokens of /l/ have a greater duration than clear tokens. This appears to be the case for individual speakers and also between speakers with different resonance distribution patterns. Contains 22 references. (MSE)

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ED 399 778

THE NATURE OF RESONANCE IN ENGLISH: AN INVESTIGATION INTO LATERAL ARTICULATIONS*

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THE NATURE OF RESONANCE IN ENGLISH: AN INVESTIGATION INTO LATERAL ARTICULATIONS*

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1. Introduction

This paper presents an instrumental study into the nature of clear and dark sounds in English. 'Resonance' is a term which I shall be using to cover the range of quality distinctions covered by the terms 'clear' and 'dark' (and intermediate varieties).[1] The term 'resonance' has been used by a number of linguists in the past (see, for example, Abercrombie 1936, Allen 1953, and Jones 1956), as well as more recently (Kelly and Local 1986). However, its use as a phonetic label is far from universal.

2.1. The Nature of Resonance

The instrumental study detailed here will primarily look at those resonance features which are associated with the lateral consonant /l/ in

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* Most of the work detailed here was carried out whilst at the University of York. The author can currently be contacted at Department of Linguistics, University of Edinburgh, Adam Ferguson Building, 40 George Square, Edinburgh EH8 9LL, UK, email den@ling.ed.ac.uk. The author wishes to thank John Kelly, Geoff Lindsey, John Local and my informants for all their advice and help. I'm still to blame though.

[1] *Clear* and *dark* are not the only terms used to refer to these particular kinds of articulatory and acoustic events. Corresponding terms in the literature include the following: 'front', 'palatalised', 'having front vowel resonance'. Similarly, terms referring to darkness include: 'back', 'velarised', 'retracted', 'having back vowel resonance', 'pharyngealized'. In the main, these terms tend to refer to the same kinds of articulatory gestures. Some of these labels may be seen as more appropriate than others, although this is not an issue which is to be confronted in this paper.

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English. However, before the study and its results are described, there are three main concepts which are to be assumed in my treatment of resonance features.

Firstly, at least in their phonetic forms, dark and clear sounds are not simply opposed in a binary way. They are merely convenient labels for the opposite ends of a continuous range of distinguishable phonetic qualities. Of course, it may be the case that, when carrying out subsequent phonological analysis, one might wish to talk about a dark/clear opposition, but it is also important to recognise the range of *phonetic* variability which can be recorded.

Secondly, it often appears to be assumed in much of the literature that *clear* and *dark* are terms which only apply to the lateral consonant /l/. This has become an especially widespread assumption in that part of the literature which concentrates on the phonetics and phonology of English (see Giegerich 1992). However, work on other languages (for example, Westerman and Ward 1933), and more detailed works in general phonetics (see Jones 1956) have recognised resonance characteristics as applicable to any speech sounds.

The third point is the notion that the darkness or clearness of a token applies only to that token in a given utterance. However, upon closer examination, it can be seen that this is not the case. There have been studies suggesting that different phonetic items may have different effects on the resonance of their environment, depending on the nature of what is sometimes called their *acme function*. For instance, one study by Kelly (Kelly 1989; see also Kelly and Local 1986) examined the following two sentences, as spoken in one variety of English (from north Manchester/Salford):

(1) Ballet came to my mind.
(2) Barry came to my mind.

Electropalatography showed that the velar closure at the beginning of the word *came* was fronter following the word *ballet* than it was after the word *Barry*. Kelly proposed that, for this variety of English, /r/, in the form of an approximant, has acme function, affecting nearby parts of the utterance.

This interaction of resonance effects has also been noted by Klatt, who stated, with regard to speech synthesis, that

> 'the acoustic properties of /l/ in a word like *will* cannot be predicted from diphones obtained from *with* and *hill* because the /w/ and /l/ velarise the /l/ to a greater extent.'
>
> (Klatt, quoted in Kelly and Local 1986: 304)

There is also a fourth aspect of resonance features which will be discussed later on. This is the suggestion that dark tokens tend to occur finally, whilst clear tokens tend to occur initially. This is one of the more important, if problematical, aspects of the theory of resonance that is being investigated here, and will be discussed towards the end of the paper.

2.2 The Perception of Resonance

The major finding of Newton (1993) was related to how we perceive different types of resonance. That study, which was suggested by casual observations, used synthesised intervocalic laterals in English words and pseudowords produced using the YorkTalk speech synthesiser (see Ogden 1992) It was found that phonetically-trained subjects tended to perceive longer lateral tokens as having a darker resonance simply as a result of their duration, and regardless of their actual darkness or clearness. Similarly, shorter laterals were consistently judged as having relatively clear resonance, even though no differences other than duration were present.

The results obtained from this experiment raised the question of whether, for naturally-produced English laterals, darker varieties were, indeed, longer in duration. The present paper reports an instrumental study into this question, with special reference to initial and final positions.

3. Instrumental Study

This study used speech elicited from a number of informants, each being a speaker of a different variety of English.

It was found that the cue of duration in laterals seems to be of great importance in the perception of different degrees of resonance. It was hypothesised that this is because the actual duration of laterals in natural speech does indeed correlate with the resonance of the sound. Specifically, it would be expected that one would find that tokens of /l/ which are marked as relatively *dark* in a named variety are of a longer duration than those which are treated as *clear*.

3.1 Informants Used

All of the informants were first-year undergraduate students in the Department of Language and Linguistic Science at the University of York, with the exception of Speaker D, who is a member of staff there.

Four male speakers were used, each being a native speaker of a different variety of English. Their details (summarised below) were obtained through interview with each of the informants. They were also given a brief questionnaire about their linguistic background to ensure that these details were as accurate as possible:

Speaker A: 19 year-old male from Ashby-de-la-Zouch, Leicestershire, but has lived in a variety of other places. Not an RP speaker, but his idiolect is a fairly standard variety, somewhat influenced by northern English.

Speaker B: 19 year-old male from Bolton, Greater Manchester. States that he has a 'northwest Lancashire' accent, which is 'discernibly different from the more rhotic Lancashire accents (north and west of Bolton), and the Mancunian type accent which is east and south of Bolton', and is said by him to be a typical Bolton accent.

Speaker C: 19 year-old male from North Antrim, Northern Ireland. Judges that he has a North Antrim accent, but that his variety of it is not completely typical, in that his speech is 'a little more refined than where I come from'.

Speaker D: 48 year-old male originally from South-West London. Has an RP-like accent, and judges his accent to be 'RP-ish. Home Counties middle middle class'. Has lived in several other areas, but judges his accent as typical of his original background.

The use of all male speakers in this small-scale study was to make cross-subject comparisons less difficult during the instrumental study. Due to the configuration of the hardware and software, computer analysis of speech wave spectrograms is often said to be difficult for female speech, and so this was not attempted here. It should be noted, however, that in the perception experiment reported in Newton (1993) the subjects were of a rough split between female and male.

It was first hypothesised what resonance patterns speakers would have from their idiolect background, and these hypotheses were evaluated as part of the instrumental study. It was hoped to obtain the following resonance patterns for their respective articulations of /l/.

	Initial /l/	Final /l/
Speaker A	clear	dark
Speaker B	dark	dark
Speaker C	clear	clear
Speaker D	clear	dark

Speakers A and D have the kind of resonance patterns that are generally reported in the literature on the phonetics and phonology of (RP) English. Speaker B has what shall be called a *dark everywhere* variety, whilst Speaker C has a *clear everywhere* variety.

If it is to be assumed, following Newton (1993) and Ogden (1992), that for all speakers word-medial varieties of /l/ are of an intermediate variety with regard to their resonance, then we might expect the mean darkness (and mean duration, if the hypothesis that darker tokens of /l/ are durationally longer is true) to be classifiable into the following order (in ascending order, from clearer and shorter to darker and longer):

Speaker C → Speakers A and D → Speaker B

For the differences between Speakers A and D, it was expected that this should be in the order of

Speaker D → Speaker A

which is possibly due to the latter's general Northern English influenced speech. These claims will be investigated below.

Some further recorded materials were also used in this study. These included some tape recordings of speakers of different varieties of English producing various utterances involving /l/ and /r/ in different environments and were recorded by Kelly and Local as part of their research work on resonance (Kelly and Local 1986). These were not used here as primary material for the instrumental study, but impressionistic observations made from them were noted for purposes of comparing results with this present study.

3.2 Utterances Elicited

The informants were asked to read out a total of 27 utterances, each of them in the form of a short phrase or sentence. The utterances were as follows:

1	say silly again
2	say sillow again
3	say solly again
4	say sollow again
5	it's the whale edition
6	the whale and the shark
7	say boy again
8	say boil again
9	say boiling again
10	say Boyling again
11	say the boy Ling again
12	say May again
13	say mail again
14	say mailing again
15	say Mayling again
16	say May Ling again

17	Mr B Likkóvsky's from Madison
18	Mr Beel Hikkóvsky's from Madison
19	Mr Beau Lukkóvsky's from Madison
20	Mr Bole Hukkóvsky's from Madison
21	Mr Beelik wants actors
22	Beel, equate the actors
23	the beelic men are actors
24	I gave Beel equated actors
25	the beeling men are actors
26	the beel equipment's amazing
27	Beel equates the actors

Utterances 1-4 are for the purpose of obtaining articulations of the same stimuli that were used in the previously mentioned perception experiment.

Utterances 5 and 6 are also examined by Halle and Mohanan (1985). These were elicited here to examine how the darkness or clearness of the articulations varies with relation to morphological boundaries.

The two similar groups of Utterances 7-11 and 12-16 were devised for the purpose of seeing how darkness varies with syntactic and morphological differences. The words *mail* and *boil* should, at least for speakers A and D, be relatively dark, as should be words *mailing* and *boiling*, since the /l/ portion is still morpheme-final. However, for the words *Mayling* and *Boyling*, one might expect a clearer articulation, since the /l/ in each case can be argued to be ambisyllabic, that is to say, belonging exclusively neither to the first syllable nor to the second, with no morpheme boundary. (For argumentation on this subject, see Local 1995.) These words should be in contrast to *May Ling* and *boy Ling*, in which it would be expected that there would be a clearer articulation. (Utterances 7 and 21 were used for purposes of comparison only, since they contain no lateral articulations.)

The remaining, somewhat unusual, utterances were all used in Sproat and Fujimura (1993). For Utterances 17-20, all the contexts were trochaic in nature (*i.e.*, a stressed syllable followed by an unstressed one), the first two being in a /i - ɪ/ environment, whilst the second two were in a /o - ə/ environment. The /l/ in Utterances 17 and

19 were made syllable-initial by the nature of the words involved, whilst those in Utterances 18 and 20 were necessarily syllable-final since they were followed by an /h/. This, as Sproat and Fujimura say,

> 'cannot be part of an initial consonant cluster in English and there is therefore no chance of resyllabification.'
>
> (*ibid*)

They also mention that, since /h/ can be considered a voiceless vowel (see Catford 1977), the choice of this sound means that there is less likelihood of interference with the lingual articulation, though they note that the laryngeal gesture for /h/ may have some side-effects.

Since the remaining utterances (21-27) were primarily concerned with drawing distinctions related to different types of morphosyntactic boundaries, these were not examined in great detail. The previous utterances (1-20) were found to provide sufficient data to be able to draw some satisfactory conclusions. However, they were examined for purposes of overview and comparison, and I shall therefore also describe them here.

Utterance 21 is similar to Utterances 10 and 15, in that the /l/ is intervocalic with no boundary, which, using the theory preferred here, is to be interpreted as ambisyllabic. Utterance 22 places the /l/ before an intonation boundary, as defined by Beckman and Pierrehumbert (1986). Utterance 23 places the /l/ before a '+' boundary, which, in Lexical Phonology (see Mohanan 1986), is a Stratum I boundary, whilst Utterance 24 places the /l/ before a phrase break within a VP.

The boundary before which the /l/ occurs in Utterance 25 is what Sproat and Fujimura call a '#' boundary (Lexical Phonology's Stratum II boundary), whilst the boundary in Utterance 26 is between the two phonological words in a compound. Finally, Utterance 27 is defined by Sproat and Fujimura as placing the /l/ before a VP phrase break.

3.3 Method

Each of the four informants was asked to read out the list of utterances in the same order. This order was chosen in a semi-random manner before the recording, so that related sentences did not appear next to each other.

Informants were given ten minutes to look through the utterances, which were written on individual cards, in order for them to be familiar with what they were going to have to read out. This was especially important, since many of the utterances are of an unusual nature, and it was important to minimise any possible pronunciation errors (though this was not completely successful; see below). The informants were each told to read the cards in a natural, but careful, style. That is to say, they understood that they were to be read as individual sentences, as this was a reasonably formal scenario, but that they should not change their accent in doing this. The recordings were later judged by members of the Department who know the informants, and these instructions were deemed to have been successful.

The recording was carried out in a sound-damped recording studio environment. The recordings were sampled into a Macintosh II computer running MacSpeech Lab II version 1.7 speech analysis software. Some of the work was later carried out by transferring the files to Signalyze (version 1.40) format, running on both a Macintosh Quadra 950 and a Macintosh LCII, though most of the analysis work was done on the former system.

Much of the analysis carried out took the form of measuring durations, and by reading wide-band spectrograms, though non instrumental techniques were also used.

4. Results

It was stated earlier that attempts to reduce misarticulations were successful, though not entirely so. Some of these did not seem to have any effect on the portion of the utterance under study. Speaker C sometimes mispronounced the word *Madison* as /ˈmeɪdɪˌsən/. In addition, Speakers A and C both pronounced *Beel, equate the actors* with less of an intonation boundary than had been intended. Again, since there was no reliance on the detail of this particular utterance, this did not cause any major problems in analysis. Of perhaps slightly more importance, Speaker C also pronounced *Beelik* as /bəˈlik/, rather than /ˈbilɪk/.

Marking the start and end point for the acoustic realisation of a segment /l/ is not a straightforward task, in the sense that there are no

real *start* and *end* points for the sound. Hence, two sets of measurements were made for each of the articulations. They were:

- the minimum extent where it can be said the articulation occurs,
- the maximum extent where it can be said the articulation occurs.

An example follows. On the opposite page, the display is of a wide-band spectrogram of the word *Boyling*, as edited out of the phrase *say Boyling again*, spoken by Speaker A. The two parallel sets of vertical lines show the maximum and minimum points for my measurement of the /l/ portion. These were chosen using both visual and auditory methods. This gives two different values for the duration of the /l/, depending on which criteria one wishes to use to measure it. It is therefore possible to have two discrete sets of measurements. If these both lead to the same conclusions, then there is more motivation for treating these results as accurate. In addition, these results were averaged out, to create a value for the mean length of /l/.

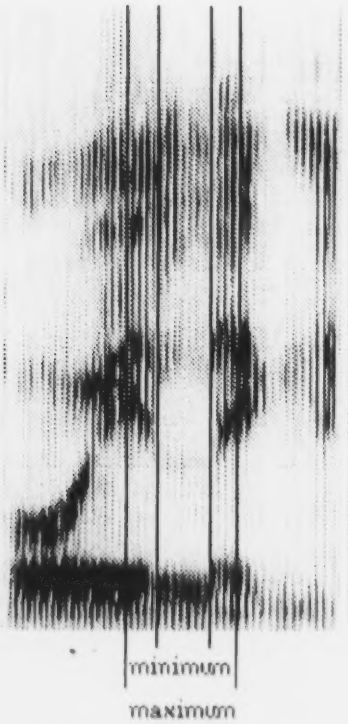
4.1 Tempo

A checking experiment was also carried out, following Kelly *et al* (1966), in order to make sure that the results were comparable across speakers. This was in relation to the tempo of the utterance. If it can be shown that the speakers' tempi are comparable (or even if they go in an opposite direction to that example given above), then we can more safely talk about the significance of any durational results that are found.

Firstly, the whole utterance was measured for each of the 27 utterances as spoken by each of the four speakers, and the total duration was noted. Secondly, a selected foot from each utterance was measured.

There were, perhaps not surprisingly, a few utterances where the tempo differences between speakers were quite large, but it was found that these differences had little impact on the overall results. The mean totals of the measurements were as follows:

	A	B	C	D
Mean length of utterance (ms)	1533	1389	1531	1440
Mean length of portion (ms)	533	485	515	540



These tempo measurements were not found to be significantly different across speakers.

It is interesting to note that, in both cases, the fastest mean tempo was from those utterances produced by Speaker B. This is the speaker who, it was hypothesised, would have longer /l/ tokens, because he had darker /l/ tokens. The fact that his speech rate was the fastest amongst the informants might suggest that, if resonance and the duration of its

features was not a factor, then he would actually have *shorter* /l/ tokens than the other speakers. Hence, it is possible to say that, if the hypothesis that he had longer /l/ tokens were upheld, then this would be all the more noteworthy.

4.2 Evaluation of Resonance Patterns

The first task was to find out whether the predicted and actual resonance patterns matched. This was done partly through examination of spectrograms, but also from listening and detailed impressionistic phonetic transcription.

It was found that the resonance distributions were largely as expected. Speakers A and D had the RP-like distribution of clear initial /l/ tokens and dark final /l/ tokens. Speaker B had dark tokens in all positions (in fact, his clearest tokens were still somewhat darker than the darkest ones produced by Speakers A or D), whilst Speaker C had very clear tokens in all positions, though some of the tokens were slightly unusual, in that they did not appear to be typical of any kind of /l/ that has been discussed in this study. Some of his /l/ tokens, particularly the intervocalic ones, were very vocalic in nature, and difficult to measure. In addition, some other intervocalic tokens which he produced were tap-like in nature.

For those speakers who had a *clear everywhere* or a *dark everywhere* distribution, their final tokens of /l/ were, relatively speaking, still darker than the initial ones. Therefore, I would suggest that the RP-type classification of /l/ as 'clear initial, dark final and intermediate medial' holds at least for all the speakers under examination here, but in a relative sense.

4.3.1 Durations: Intra-Speaker

It was expected that the degree of resonance present in the /l/ part of the articulation would be classifiable in the following order, from darkest to clearest:

8 boil
9 boiling
10 Boyling
11 boy Ling

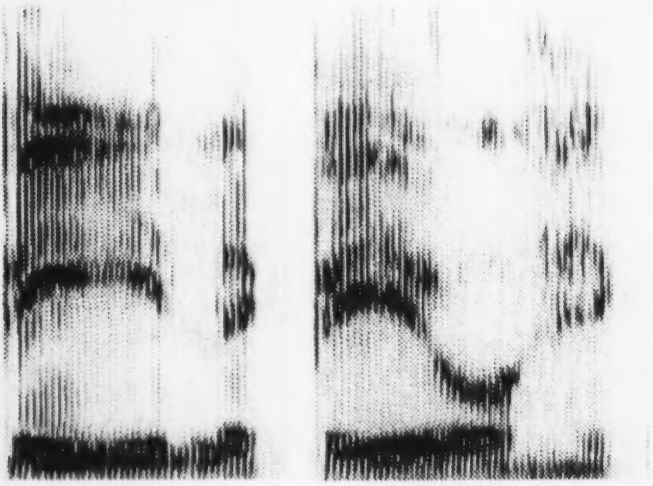
and

13 mail
14 mailing
15 Mayling
16 May Ling

This was broadly found to be the case. For the Utterances 8-11, this pattern was found decisively for Speakers A and C, whilst, for Speaker B, the pattern was the same except that Utterances 8 and 9 were difficult to distinguish in terms of their resonance. There was an equally good result for Speaker D, with the exception that his articulations of Utterances 9 and 10 were not easily distinguishable from each other.

Similar results were found for Utterances 13-16. All speakers had the expected resonance patterns, with the exception of Speaker A's production of *Mayling*, which seemed to contain a darker /l/ than his production of *mailing*. There was a possible problem with the 'expected clear' articulations of *May Ling*. Some of these, on spectrographic study, looked as if they were in fact darker than some of the articulations of *Mayling*, even though the reverse was expected. Note that the syllable initial position of the /l/ here is in a position which encouraged primary stress location, whereas, in all the other articulations, the second syllable is an unstressed one.

This problem was avoided in Utterances 17-20, in which the expected clear articulations *B. Likkóvsky* and *Beau Lukkóvsky* are contrasted with the expected dark articulations *Beel Hikkóvsky* and *Bole Hukkóvsky*, whilst the pattern of stressed and unstressed syllables is not disrupted, as may have been the case for the articulations *boy Ling* and *May Ling*. In all cases, the expected clear articulations were found to be obviously and substantially clearer than the expected dark ones. This can be seen in the following two spectrograms (over), which are both from Speaker A.



B. Li
(*from* B. Likkóvsky)

Beel Hi
(*from* Beel Hikkóvsky)

The main visual difference between these two spectrograms is the difference in the second formant. The darker variety, on the right, has F2 falling to a much greater extent than occurs in the clearer articulation. Also, the third formant follows a similar pattern to the second in the clearer articulation, whilst, in the darker variety of lateral shown here, it moves upwards, away from the second formant. Differences in amplitude of F1 are also visible.

It was mentioned earlier that some of the informants' articulations of various /l/s were not easily recognisable. This was especially the case for Speaker C. Some of his intervocalic varieties were very vocalic in nature, making them quite difficult to segment satisfactorily. His initial varieties were also sometimes quite tap-like in nature. Speaker D produced some intervocalic articulations of /l/ which were quite fricative in nature. However, this did not cause any particular measuring difficulties.

Having ascertained that the resonance distribution was as expected, it was possible to investigate whether or not the durations of these /l/s were in a predictable distribution with the resonance.

By averaging the durations for all speakers, and including both the 'minimum length' measurement and the 'maximum length' measurement, it was found that, in the main, the results were as expected. That is to say, those articulations of /l/ which were darker in resonance also had a longer duration.

• boil	70.5
• boiling	54.25
• Boyling	52.75
• *boy Ling*	*62.5*
• mail	79.5
• mailing	50
• Mayling	46.625
• *May Ling*	*75.125*
• Beel Hikkóvsky	77.5
• B. Likkóvsky	60.875
• Bole Hukkóvsky	85.25
• Beau Lukkóvsky	73.375

In the case of the italicised articulations, the reverse durational effect has occurred. However, it was found that this unexpected effect was due to the difference in stress patterning (see above), and these results were discarded. It was then possible to directly compare the top two sets of measurements with the bottom two pairs of utterances which avoid this problem. Doing this, we find that the results are as expected, with the darker varieties appreciably longer than the clear varieties.

If the results are considered for each individual speaker, or for each of the two measuring methods, the results are not quite so consistently in favour of the hypothesis. However, no one informant's results went consistently against the hypothesis.

4.3.2 Durations: Inter-Speaker

The next piece of analysis to be carried out was to find out whether those speakers with a generally darker variety generally have longer /l/s, and whether the reverse is the case for those speakers who have an clearer variety.

The first results which were obtained were derived from averaging out *all* of the measured utterances across each speaker, regardless of in what position the lateral occurred. They were, however, not as hypothesised:

	Mean duration of /l/ (msec)
Speaker A	60.556
Speaker B	70.860
Speaker C	61.889
Speaker D	66.368

Where we would have expected Speaker C to have the shortest durations and Speaker B to have the longest, with Speakers A and D somewhere in the middle, we find that Speaker C has an intermediate value. This aside, the other speakers results are as expected, with Speaker B having an appreciably longer mean duration of /l/.

On finding this unexpected result, referral was made to notes which were made during the instrumental study. For the *B. Likkóvsky* set of four utterances, the articulations of /l/ produced by Speaker C were very difficult to segment (see above). These are the ones which, it had been noted earlier, seemed very tap-like (or at least, certainly non-lateral) when under spectrographic and impressionistic study. As a result of this, it was decided to measure these averages again, but this time leaving out these problematical four utterances. The results which were obtained this time were as follows:

	Mean duration of /l/ (msec)
Speaker A	62.429
Speaker B	70.106
Speaker C	52.210
Speaker D	64.259

It can be seen that the means for Speakers A, B and D remained almost the same, but that for Speaker C decreased by fifteen per cent. This resulted in the distribution being as originally anticipated, with the three groups of speakers (those with a generally clear pattern, those with a generally dark pattern, and those with a mixed pattern which averages out as central) each being separated by a substantial amount, around ten milliseconds in each case.

Since the laterals which were in the original perception experiment were all ambisyllabic intervocalic varieties, the means of those utterances which involved this variety of /l/ were measured for comparison. These utterances were the ones which contained the following articulations:

- silly
- sillow
- solly
- sollow
- Boyling
- Mayling

The mean durations for these /l/s were as follows:

	Mean duration of /l/ (msec)
Speaker A	52.30
Speaker B	69.83
Speaker C	46.58
Speaker D	53.00

Once again, these results were in line with what could be predicted from the results obtained in the perception experiment.

5. Summary

The results given in the above two sections support the hypothesis that darker tokens of /l/ have a greater duration than clearer tokens. This appears to be the case both for individual speakers, and also between speakers who have different resonance distribution patterns.

Some caution may be required here. I would not like to suggest that this pattern is always consistent, since the effects on resonance of morphosyntactic boundaries and their interaction with vocalic environment (and, for instance, whether one of these two factors is prime over the other) does not, as yet, appear to be sufficiently understood. In fact, as I have mentioned, some of the initial results did go against what was expected, but, to a far greater extent, the hypothesis was supported.

6.1 Discussion

One question that has been raised is whether, in general, dark tokens (of anything) are (relatively) long. Of course, since the darker varieties of /l/ which were looked at were mostly those in a final position, it is also possible that final tokens are long, regardless of whether they are dark or not. Similarly, those varieties of /l/ which were clearer were usually those which were in initial position, and there is the question of whether this is the nature of the /l/, or the nature of the position within the word, or a combination of the two. The results which were found can be schematised thus:

For /l/ only	Initial	Final
Speakers A and D	Short Clear	Long Dark
Speaker B	Long Dark	Long + Dark +
Speaker C	Short Clear	Short – Clear –

Here, a '+' sign represents that there is 'more of' the quality indicated, and a '–' represents 'less of' that quality. The actual labels themselves (*clear, dark, long, short*) represent the classifications that we might wish to give phonologically, whilst the additions of '+'s and '–'s are of a more phonetic nature.

It can be seen from the above diagram that all speakers, phonetically, do go in the same direction in terms of the durational features of their /l/s. For the order Initial→Final, all Speakers would have the order Short→Long.

This question of the possible lengthening of final items is raised by Vaissière (1983). She categorises *Final Lengthening* as a 'language-independent prosodic feature', giving examples of several languages which display this phenomenon, including French, English, German, Spanish, Italian, Russian and Swedish. However, as Vaissière admits (1983: 60), it may be too much of a generalisation to state this a universal, since there is contrary data for several languages, including Finnish, Estonian and Japanese.

If Final Lengthening could be shown to be, if not a universal, then at least a tendency, then one might wonder if there were any physiological or other reasons why this might happen. Vaissière reports several suggestions that have been hypothesised by various studies. She mentions that there may be a general relaxation of speech gestures toward the end of utterances and that this decrease in amplitude may be compensated for by increasing the duration. However, this seems to me to be a strategy that is more likely to be language-specific (or, to be more precise, dialect-specific), since we have the above examples where it does not occur. In fact, Vaissière notes that there have been studies of children, who seem not to display the tendency of final lengthening, thus suggesting that this is a learned process.

6.2 Further Study

Two areas would be relevant for investigation. Firstly, it would be interesting to find a language variety where laterals were clearer and shorter in final position. Secondly, and more generally, it would be helpful to find a language variety where non-lateral tokens were notably shorter finally than initially (perhaps regardless of resonance).

Some of these possibilities may be true for some Scottish dialects. Work carried out by the Scots Section of the Linguistic Survey of Scotland (see Hill 1960; also Hill p.c.) has suggested that some dialects of Scottish English may have very clear final tokens of some alveolars, nasals and plosives. These dialects and their resonance patterns are now being researched. If it transpires that these claims are true, it would be

interesting to examine the durational properties of these sounds. If they were found to be relatively long, then this would add support to the Final Lengthening cause, whilst, if they turn out to be short, this would support the suggestion of a darkness/length correlation. In fact, preliminary non-experimental observations suggest that the latter may be the case.

I suggested above that final lengthening of /l/, if not a universal, may be a tendency. If it is assumed for the moment that this is the case, then it is then necessary to look for possible explanations. If longer tokens of /l/ usually coincide with articulations of a darker resonance, there are some reported physiological reasons why this may be so. Amerman and Daniloff (1977) studied lingual coarticulation, though they do not explicitly link dorsal gestures with increased length. However, they do suggest that the gesture of the tongue apex is the more important of the two, and that the dorsal position generally, in terms of anticipation of vowels, 'does not need to adopt so specific a position' (1977: 112). It seems possible that dorsal gestures generally take longer to activate, particularly since this would seem to involve more muscular activity, and this would be a possible explanation for the lengthening of dark tokens. That is to say, dark tokens (in this case, of /l/) have a more prominent dorsal component and dorsal components may inherently require a longer articulation period.

If this last suggestion is, indeed, a reasonable one, then it would seem to remove the need for the use of the concept of Final Lengthening, since, rather than talking about the lengthening of final items, what is here being talked about is the lengthening of the *dorsal* (or dark) items.

If further study supports this, then this would seem to tie in well with recent work carried out by Sproat and Fujimura (1993). They model all articulations of /l/ as having an apical gesture, which is consonantal in nature, and a dorsal gesture, which is vocalic in nature. One difference which they draw between clear articulations of /l/ and dark articulations is that, in clear articulations, the apical gesture occurs first, whilst, in dark articulations, the dorsal gesture occurs first. In addition, they note that

> 'the acoustically measured duration of the rime containing a preboundary /l/ correlates strongly with darkness.'
>
> (1993: 2)

They propose that the vocalic gesture has an affinity for the nucleus of the syllable, whilst the consonantal gesture has an affinity for the margin. These gestures make use of different lingual muscles. Their claim is that coarticulatory undershoot accounts, to an extent, for the correlation of darkness with duration. They also define the notion *Tip Delay*, which has a positive value in final (here, darker, tokens) and a negative value in initial tokens.

However, Sproat and Fujimura only correlate duration with resonance in the case of coda-position /l/s (1993: 18). They do not explicitly state that this is the case for all positions, nor do they suggest that this correlation is as important for perception as implied by Newton (1993). That is to say, it seems to be the case that the durational aspect of laterals may have primary status in the perception of resonance, since it has been shown that manipulation of duration affects resonance judgements when no other differences are present.

They do, however, state that their discoveries may only apply to those varieties of English which have the clear/dark distinction. They mention that there are varieties which do not display this distinction, and that there are also other languages which do not. However, of course, for the varieties used in my own instrumental study, even those which were said to be 'clear /l/ everywhere' and 'dark /l/ everywhere', were shown to have perceptible differences within these categories. As yet, I am not aware of any varieties of English having a perceptibly and consistently clear /l/ in final positions and a darker /l/ in initial positions. We do find varieties of English in which /r/, syllable-finally, is clear (for rhotic dialects, or other situations where it is pronounced), and syllable-initially is dark. However, Sproat and Fujimura do not attempt to extend their findings to any tokens other than /l/.

Nevertheless, their model could hold for other, non-lateral sounds, since the tongue gestures (as secondary articulations) for clearness and for darkness would differ in similar ways, regardless of the nature of the primary articulation.

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6.3 Implications

Provided that some of the work suggested in the previous section were carried out, and that this could provide more concrete evidence for some of the suggestions presented in this paper, there would appear to be two possible implications for these findings. Firstly, there may be implications for the theory of speech production (as well as speech perception), in light of the possible clash between Sproat and Fujimura's production model and the Final Lengthening model (and in light of the perceptual findings of Newton 1993).

These findings may also have some importance in phonetic and phonological modelling, for example, in speech synthesis and speech recognition. If length is an inherent and predictable part of the structure coincident with resonance (whether this is only for laterals, or for other sounds), then it would appear to be important to ensure correct modelling of both the resonance features and these durational aspects.

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